10. DETAILED ANALYSIS OF ALTERNATIVES

This section documents the detailed analysis of alternatives retained in the initial screening (refer to Section 9.6). Results of this analysis will form the basis for future activities such as identification of a preferred alternative for the sites and preparation of the Proposed Plan. Subsequent to appropriate review and comment of the Remedial Investigation/Feasibility Study (RI/FS) and the Proposed Plan, the detailed analysis will support the final selection of remedial actions for the OU 9-04 sites and preparation of the Record of Decision (ROD).

10.1 Introduction

The detailed analysis section assesses remedial action alternatives with respect to nine evaluation criteria. This analysis is more thorough and extensive than the initial screening presented in Section 9. The nine evaluation criteria form the basis for conducting the detailed analysis, which influences selection of an appropriate remedial action. The intent of this analysis is to present relevant information in sufficient detail to allow decision-makers [i.e., Department of Energy-Chicago Operations Office (DOE-CH), Environmental Protection Agency (EPA), and Idaho Department of Health and Welfare (IDHW)] to select an appropriate alternative. Evaluation against the nine criteria is the basis for determining the ability of a remedial action alternative to satisfy Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) remedy selection requirements.

The detailed analysis is conducted in two distinct phases. Initially, alternatives are assessed individually against the evaluation criteria. Results of the individual analysis are then used in a relative or comparative analysis (second phase). This second analysis identifies advantages and disadvantages of the alternatives relative to one another, so that key tradeoffs which decision makers must balance can be identified.

A description of each evaluation criterion outlined in 40 CFR 300.430(e)(9)(iii) is presented below.

10.1.1 Overall Protection of Human Health and the Environment

Alternatives shall be assessed to determine whether they can adequately protect human health and the environment, in both the short and long term, from unacceptable risks posed by hazardous substances, pollutants, or contaminants present at the site by eliminating, reducing, or controlling exposures to levels established during the development of remediation goals consistent with 40 CFR 300.430(e)(2)(i). Overall protection of human health and the environment draws on the assessments of other evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with applicable or relevant and appropriate requirements (ARARs).

10.1.2 Compliance with ARARs

The alternatives shall be assessed to determine whether they meet ARARs under federal environmental laws and state environmental or facility siting laws or provide grounds for invoking one of the waivers in 40 CFR 300.430(f)(1)(ii)(C).

10.1.3 Long-Term Effectiveness and Permanence

Alternatives shall be assessed for the long-term effectiveness and permanence they afford, along with the degree of certainty that the alternative would prove successful. Factors that shall be considered, as appropriate, include:

- Magnitude of residual risk remaining from untreated waste or treatment residuals remaining at the conclusion of the remedial activities. The characteristics of residuals should be considered to the extent that they remain hazardous, taking into account their volume, toxicity, mobility, and propensity to bioaccumulate.

- Adequacy and reliability of controls such as containment system and institutional controls that are necessary to manage treatment of residuals and untreated waste. This factor addresses, in particular, the uncertainties associated with land disposal for providing long-term protection from residuals; the assessment of the potential need to replace technical components of the alternative, such as a cap, slurry wall, or treatment system; and the potential exposure pathways and risks posed should the remedial action need replacement.

10.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

The degree to which the alternatives employ recycling or treatment that reduces toxicity, mobility, or volume shall be assessed, including how the treatment is used to address the principal threats posed by the site. Factors that shall be considered, include the (a) treatment or recycling processes that the alternatives employ and the materials they will treat; (b) amount of hazardous substances, pollutants, or contaminants that will be destroyed or recycled; (c) degree of expected reduction in toxicity, mobility, or volume of the waste because of the treatment or recycling and the specification of which reductions are occurring; (d) degree to which the treatment is irreversible; (e) type and quantity of residuals that will remain following treatment, taking into consideration the persistence, toxicity, mobility, and propensity to bioaccumulate of such hazardous substances and their constituents; and (f) degree to which treatment reduces the inherent hazards posed by the principal threats at the site.

10.1.5 Short-Term Effectiveness

The short-term impacts of the implementation period for each of the alternatives shall be assessed considering the (a) short-term risks that might be posed to the community during implementation of an alternative, (b) potential impacts on workers during remedial action and the effectiveness and reliability of protective measures, (c) potential environmental impacts of the remedial action and the effectiveness and reliability of mitigative measures during implementation, and (d) time until protection is achieved.

10.1.6 Implementability

The ease or difficulty of implementing the alternatives shall be assessed by considering the following types of factors, as appropriate: (a) technical feasibility, including the technical difficulties and unknowns associated with the construction and operation of the technology, reliability of the technology, ease of undertaking additional remedial actions, and ability to monitor the effectiveness of the remedy;

(b) administrative feasibility, including activities required to coordinate with other offices and agencies and the ability and time needed to obtain any necessary approvals and permits from other agencies (for offsite actions); and (c) availability of services and materials, including the availability of adequate offsite treatment, storage capacity, and disposal capacity and services; availability of necessary equipment and specialists, and provision to ensure any necessary additional resources; availability of services and materials; and availability of prospective technologies.

10.1.7 Cost

The types of costs assessed include (a) Federal Facility Agreement/Consent Order (FFA/CO) management and oversight costs, which would be incurred primarily by the Argonne National Laboratory-West (ANL-W) Environmental Restoration (ER) Program and secondarily the Idaho National Engineering and Environmental Laboratory (INEEL) ER Program; (b) cleanup costs, including construction management and oversight, Remedial Design/Remedial Action (RD/RA) document preparation, and reporting costs; (c) remedial design costs; (d) construction costs, including General and Administrative (G&A) and construction subcontract fees; (e) operations costs; and (f) surveillance and monitoring costs. All initial and future life-cycle costs are normalized to present worth. Present worth is the cumulative worth of all costs, as of the beginning of the first year of activities, accounting for inflation of future costs. Present worth costs were estimated assuming variable annual inflation factors for the first 10 years, in accordance with the ANL-W projected future cost estimating procedures, and a constant 5% annual inflation rate after that. A constant 5% discount rate is assumed.

Note that in all cases the "Construction Subcontract" costs, i.e., the actual costs of construction, are much less than the present worth. Management and oversight, by ANL-W and the construction contractor, account for a significant fraction of the total present worth in some cases. 100 years of maintenance, surveillance, and monitoring also become a significant part of the present worth for those alternatives incorporating long-term maintenance and monitoring.

The alternative cost estimates are for comparison purposes only and are not intended for budgetary, planning, or funding purposes. Estimates have a range of accuracy of +50 to -30%, in accordance with CERCLA (EPA 1988) guidance.

10.1.8 State Acceptance

State concerns regarding the RI/FS will be resolved before the Proposed Plan is issued for public comment.

10.1.9 Community Acceptance

This assessment includes determining which components of the alternatives interested persons in the community support, have reservations about, or oppose. The assessment of community acceptance will be completed through comments received during public meetings and written comments on the Proposed Plan.

Alternatives are not evaluated according to state and community acceptance during the detailed analysis. In accordance with CERCLA guidance, these final two criteria will be evaluated following public

comment on the RI/FS report and the Proposed Plan (EPA 1988). The two criteria will be addressed during selection of a remedy and while the Record of Decision (ROD) is being prepared (EPA 1988).

10.2 Individual Analysis of Alternatives

In accordance with CERCLA RI/FS guidance, remedial action alternatives retained for detailed analysis are individually assessed against the evaluation criteria listed above, not including state and community acceptance. The individual analysis of each alternative is presented in the following subsections.

10.2.1 Alternative 1: No Action

The no action alternative provides a baseline with which other alternatives can be compared. This alternative consists of soil, air and groundwater monitoring to assess conditions at OU 9-04 sites.

10.2.1.1 Overall Protection of Human Health and the Environment. Under the no action alternative, human health and environmental risks at OU 9-04 sites would be the same as those identified in the Baseline Risk Assessment (BRA). The absence of controls for contaminated soils results in no reduction in long-term risks other than by natural radioactive decay. For purposes of this FS and in order to meet the intent of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), it is assumed that under the no action alternative, the sites could become immediately accessible to the general public.

10.2.1.2 Compliance with ARARs and TBCs. Table 10-1 presents the evaluation of the no action alternative for compliance with the ARARs and to-be-considered (TBCs) identified in Tables 7-4 and 7-5, respectively. While the no action alternative does not involve any construction or operational activities that would result in disturbances to the surfaces of the OU 9-04 sites, IDAPA 16.01.01650 could nonetheless apply to any sites that were a source of fugitive dust and is therefore considered an ARAR that would not be met. If metals and/or semi-volatile compounds were present in fugitive dust, then IDAPA 16.01.01.210 and 16.01.01.585-586 are ARARs that would not be met. 40 CFR 122.26 would similarly apply, and would not be met. 40 CFR 141 would be met by ongoing groundwater monitoring.

The no action alternative would not meet DOE orders because health risks to current workers and potential future residents exceed allowable ranges.

10.2.1.3 Long-Term Effectiveness and Permanence. Long-term effectiveness of the no action alternative for the three soil categories evaluated in the FS is considered low. This alternative does not provide any control of human exposure to sites contaminated with radionuclides or protection of the ecological receptors.

10.2.1.4 Reduction of Toxicity, Mobility, or Volume Through Treatment. No treatment is associated with this alternative.

10.2.1.5 Short-Term Effectiveness. This alternative can be implemented immediately without additional risks to the community, workers, or the environment. No specialized equipment, personnel, or services are required to implement the no action alternative. However, Remedial Action Objectives (RAOs) would not be satisfied because the current occupational human health risk from external exposure to

radiologically contaminated soils identified in the BRA are greater than 1E-04. Risks to ecological receptors would likewise not be reduced

Table 10-1. Evaluation of ARARs and TBC compliance for Alternative 1: no action.

ARAR Statute	ARAR Type	Citation	Retain ARAR	Met Evaluation
Idaho Fugitive Dust Emissions	Action	IDAPA 16.01.01650 et seq.	Yes	No
Toxic Substances	Action	IDAPA 16.01.01161	No	N/A
Idaho Hazardous Waste Management Act	Action	- IDAPA 16.01.05.004 and .005 (40 CFR 260.10 and 261.2—"Definition of Solid Waste" - IDAPA 16.01.05.006 (40 CFR 262.11)—"Hazardous Waste Determination" - IDAPA 16.01.05.005 (40 CFR 261)—"Identification and Listing of Hazardous Waste" - IDAPA 16.01.05.008 (40 CFR 264)—"Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities - IDAPA 16.01.05.011 (40 CFR 268)—"Land Disposal Restrictions"	No	N/A
NESHAPS-Radionuclides other than Radon-222 and Radon-220 at DOE facilities -Emission Standard	Chemical	40 CFR 61.92	No	N/A
Rules for the Control of Air Pollution in Idaho	Chemical	IDAPA 16.01.01.210, 16.01.01585 and 16.01.01586	Yes	No
Safe Drinking Water Act	Chemical	40 CFR 141	Yes	Yes
National Historic Preservation Act	Location	16 USC 470 et seq.	No	N/A
Storm Water Discharges	Location	40 CFR 122.26	Yes	No
Seismic Considerations	Location	IDAPA 16.01.05.008 (40 CFR 264.18 and 270)	No	N/A
Idaho Hazardous Waste Management Act	Location	IDAPA 16.01.05.008	No	N/A
Prevention of Significant Deterioration of Air Quality	Location	IDAPA 16.01.01.581	No	N/A
Environmental Protection, Safety, and Health Protection Standards	TBCs	DOE Order 5480.4	Yes	No
Radioactive Waste Management	TBCs	DOE Order 5820.2A	Yes	No
Radiation Protection of the Public and Environment	TBCs	DOE Order 5400.5	Yes	No

ARAR = Rule is an ARAR (Yes/No)
Met Evaluation = The ARAR or TBC is met by alternative
TBC = Rule is a TBC
N/A = Not Applicable.

10.2.1.6 Implementability. No implementation concerns are involved with the no action alternative.

10.2.1.7 Cost. The costs associated with the no action alternative involve only radiation surveys. Estimated present worth costs for the no action alternative for all sites are shown in Table 9-1. Postclosure costs were estimated for the full duration of the 100-year period of monitoring. The alternative cost estimates are for comparison purposes only and not intended for budgetary, planning, or funding purposes, and are regarded as reasonable for the 100 years following site closure.

10.2.1.8 State Acceptance. IDHW/DEQ comments have not been received on the OU 9-04 RI/FS report since it is going out as a draft final. ANL-W anticipates that this alternative would not be selected as an acceptable alternative by the IDHW/DEQ and EPA

10.2.2 Alternative 2: Limited Action

This alternative does not meet the RAOs for either of the two soil categories in the FS (radiologically contaminated soils and sites with ecological concerns). Thus, this alternative was screened from inclusion in the detailed analysis in Section 9.6 of this report. However,certain activities in Alternative 2, such as access restrictions, deed restrictions, and fencing could be added to other retained alternatives.

10.2.3 Alternative 3a: Engineered (SL-1 Type) Barrier

The primary remedial action involved with this alternative is the construction of an engineered cover. Environmental monitoring, access restrictions, and surface water diversion are also included with this alternative. The engineered cover is designed to isolate radioactive wastes in place, from potential migration pathways of concern, and to reduce surface exposures to background levels. In addition, this barrier minimizes wind and water erosion that could result in contaminant migration. This barrier is approximately 4 ft (1.2 m) thick, with functional redundancy in the layers such that minimal maintenance is required for the duration of risk, which is calculated to be 130 years for Cs-137 radiological contaminants.

10.2.3.1 Overall Protection of Human Health and the Environment. This alternative is expected to be highly protective of human health and the environment for at least the 130 years for which the barrier is designed at OU 9-04, Cs-137 contaminated soil sites. For the Ra-226 radioligical contaminant in the Industrial Waste Pond, it is anticipated that this alternative would provide adequate protection against the direct exposure because of the large mass of the cap material. The engineered cover ensures long-term protection by use of natural construction materials approximately 4 ft (1.2 m) thick. Functional requirements of this cover would include inhibiting human and biotic intrusion, as well as meeting other RAOs listed in Section 7.3. The thickness of this barrier would be more than sufficient to shield against penetrating radiation above background levels (see Section 9.3.3). Furthermore, this barrier would be designed to inhibit inadvertent human intrusion, and resist erosion from wind and surface water runoff. The cap is designed to inhibit the depth of infiltration of water, thus, limiting the depth of the root zone to the upper clean cap material. This barrier would also inhibit biotic intrusion, thereby controlling exposure pathways to environmental receptors. Short-term risks to workers and the environment during installation of the engineered cover are low to moderate (see Section 10.2.4.5).

10.2.3.2 Compliance with ARARs. Table 10-2 presents the evaluation of the containment alternatives for compliance with the ARARs and TBCs identified in Tables 7-4 and 7-5, respectively. Potential radionuclide and dust emissions during construction of protective covers at OU 9-04 sites are controllable with the use of water sprays. No emissions would be anticipated once a protective cover is in place. Activities associated with the containment alternatives would not constitute an emissions "source" and therefore do not trigger IDAPA 16.01.01.585-86 as an ARAR. The National Emissions Standards for Hazardous Air Pollutants (NESHAP) (40 CFR 61.90) is an ARAR for the containment alternatives, and would be met by eliminating all exposure pathways. ARARs, apply equally to both containment alternatives.

Substantive requirements of 40 CFR 264.228(b) and of 264.117 through 264.120 would also have to be met. An SL-1-type engineered cover would not meet the RCRA functional requirements for minimizing liquid migration listed above. The engineered cover would be designed to limiting infiltration only to the cap and not the contaminants below the cap.

No OU 9-04 sites are within 200 m of a known fault which has had displacement in Holocene time, therefore seismic considerations would be met.

State of Idaho rules for Prevention of Significant Deterioration of Air Quality (IDAPA 16.01.01.581) specifically excludes PM-10 increases due to construction, which would be the only expected potential increase of listed pollutants. Dust control during excavation and construction would also help to control emissions.

All applicable provisions of DOE orders would be met through the CERCLA RI/FS process, and by enforcing applicable provisions of the orders. The CERCLA process has been demonstrated to meet all applicable requirements of DOE Order 5820.2A Chapter III, Section 3(a) through (m) at other DOE sites through compliance with ARARs, TBCs, and the information acquired and planning implemented through the process. DOE Order 5820.2A Chapter III, Section 3 includes requirements in the following areas:

- Performance objectives
- Performance assessment
- Waste generation
- Waste characterization
- Waste Acceptance Criteria
- Waste treatment
- Shipment
- Long-term storage
- Disposal
- Disposal site closure/postclosure
- Environmental monitoring
- Quality assurance
- Records and reports.

All applicable elements of these requirements have been determined to be met through the CERCLA process. Requirements of DOE Order 5400.5, "Radiation Protection of Public and the Environment" would be met through elements of the RI/FS process including risk assessment, and defining RAOs and

Table 10-2. Evaluation of ARARs and TBCs compliance for Alternative 3a: engineered containment.

ARAR Statute	ARAR Type	Citation	Retain ARAR	Met Evaluation
Idaho Fugitive Dust Emissions	Action	IDAPA 16.01.01650 et seq.	Yes	Yes
Toxic Substances	Action	IDAPA 16.01.01161	Yes	Yes
Idaho Hazardous Waste Management Act	Action	- IDAPA 16.01.05.004 and .005 (40 CFR 260. 0 and 261.2—"Definition of Solid Waste" - IDAPA 16.01.05.006 (40 CFR 262.11)—"Hazardous Waste Determination" - IDAPA 16.01.05.005 (40 CFR 261)—"Identification and Listing of Hazardous Waste" - IDAPA 16.01.05.008 (40 CFR 264)—"Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities - IDAPA 16.01.05.011 (40 CFR 268)—"Land Disposal Restrictions"	Yes	Yes
NESHAPS-Radionuclides other than Radon-222 and Radon-220 at DOE facilities -Emission Standard	Chemical	40 CFR 61.92	Yes	Yes
Rules for the Control of Air Pollution in Idaho	Chemical	IDAPA 16.01.01.210, 16.01.01585 and 16.0 .01586	Yes	Yes
Safe Drinking Water Act	Chemical	40 CFR 141	Yes	Yes
National Historic Preservation Act	Location	16 USC 470 et seq.	No	N/A
Storm Water Discharges	Location	40 CFR 122.26	Yes	Yes
Seismic Considerations	Location	IDAPA 16.01.05.008 (40 CFR 264.18 and 270)	Yes	Yes
Idaho Hazardous Waste Management Act	Location	IDAPA 16.01.05.008	Yes	Yes
Prevention of Significant Deterioration of Air Quality	Location	IDAPA 16.01.01.581	Yes	Yes
Environmental Protection, Safety, and Health Protection Standards	TBCs	DOE Order 5480.4	Yes	Yes
Radioactive Waste Management	TBCs	DOE Order 5820.2A	Yes	Yes
Radiation Protection of the Public and Environment	TBCs	DOE Order 5400.5	Yes	Yes

ARAR = Rule is an ARAR (Yes/No)
Met Evaluation = The ARAR or TBC is met by alternative
TBC = Rule is a TBC
N/A = Not Applicable.

formulating remedial alternatives that meet RAOs. Requirements of DOE Order 5480.4, "Environmental Protection, Safety and Health Protection Standards" would be met by enforcing all applicable provisions of the order during implementation and the institutional control period, through the RI/FS process. These alternatives are therefore considered capable of complying with all ARARs and TBCs identified.

10.2.3.3 Long-Term Effectiveness and Permanence. The long-term performance of this alternative is considered to be highly effective for preventing external exposure to contaminated surface soil. The engineered cover is designed to maintain its effectiveness for at least 130 years with minimal maintenance requirements. After 130 years the Cs-137 would have decayed below the PRGs and only minor repair of the uppermost layer that may have been displaced by animals or erosion would be required. The majority of the cap mass would remain and provide a physical barrier against the direct exposure of the Ra-226 contamination. The functional requirements of the design are to provide sufficient shielding to reduce direct radiation exposure to allowable levels, and resist erosion, and resist biotic and human intrusion. Although the engineered cover is designed to be maintenance-free, cap integrity monitoring, as well as periodic removal of undesirable vegetation and burrowing animals (if necessary) are maintenance requirements that will be performed during the period of institutional control.

Erosion and human intrusion are the most likely causes of barrier failure resulting in the external exposure to contaminated surface and buried soil. The physical size of the engineered cover and the coarse texture of the component layers specified in the design are considered effective for erosion resistance. Human intrusion through the basalt rip-rap layer would also be difficult, but no barrier can prevent intentional human intrusion.

10.2.3.4 Reduction of Toxicity, Mobility, or Volume Through Treatment. No treatment is associated with this alternative.

10.2.3.5 Short-Term Effectiveness. Exposure of construction workers during installation of a protective cover would be minimized by the distance of the worker on the equipment from the contaminated soil. This is further reduced via the enclosed cab on the excavation equipment. Emplacement of foundation material and the lowermost layer(s) of the cover would add additional shielding sufficient to eliminate subsequent exposure risks throughout the remainder of construction activities based on shielding calculations presented in Section 9. Inhalation and ingestion risks could be minimized by the use of appropriate personal protective equipment (PPE), engineering controls, and adherence to health and safety protocol. Based on DOE Order 5480.11, construction activities would be performed in accordance with the as-low-as-reasonably-achievable (ALARA) approach to radiation protection.

Nonexposure risks to workers are also considered during consolidation of surface soils (if necessary) and construction of the barriers. These risks result primarily from physical construction hazards, such as vehicle accidents or personal injuries. These hazards can be minimized by implementation of appropriate health and safety measures for earth-moving construction activities.

All construction materials for the cap designs are available at the INEEL or within the surrounding communities. Shipment from distant offsite locations is not anticipated to be required. Therefore, no risks are associated with transportation of construction materials.

Environmental impacts resulting from excavation and construction activities would be minimal. Materials would be excavated, transported, and placed entirely within previously disturbed areas. Installation of surface water diversion control ditches might result in alteration of the nearby terrain. However, the overall impact of these activities is not considered irreparable and would be unnoticeable in the long term. The remoteness of the site would prevent any impact to the surrounding communities during construction activities. No environmentally sensitive areas such as archaeological or historical sites, wetlands, or critical habitat exist in the vicinity of the OU 9-04 sites, since all are in previously disturbed areas.

RAOs would be achieved by either containment alternative once construction of the barrier is complete. Approximately 12 to 15 months is assumed for design, procurement, and equipment and personnel mobilization. For the purpose of this FS, it is assumed that the engineered cap (3a) can be constructed over any OU 9-04 site within a 3-month period, based on the construction schedules used for the INEEL OU 5-05/6-01 caps. Administrative, technical, and other personnel would be involved; in addition, approximately 6–10 construction workers would be required onsite during construction.

10.2.3.6 Implementability. Institutional controls and surface water diversion controls are easily implementable this alternative, based on the availability of monitoring, access restriction, and runoff-control technologies. Personnel specifically trained to work in radioactively-contaminated areas are available in the communities surrounding the INEEL.

Additional future remedial actions required after emplacement of a cover or barrier would be difficult to implement because of the large amount of materials that would be placed over the site.

This engineered cap (3a) remedial action would be the most consistent with the prior interim remedies at the INEEL. The OU 10-06 Removal Action filled the 1952 and 1957 cells to near capacity with low-level radionuclide contaminated soils from other sites on the INEEL. The final remedy most consistent with the prior interim remedies would be containment in place.

Monitoring the effectiveness of containment for preventing external exposure to the contaminated soils would require only visual inspection to determine the integrity of the barrier. However, radiation surveys would be performed as part of the institutional controls in order to verify containment. The containment of soils from sites that have ecological concerns would be ensured as long as the barrier remained intact. Postclosure monitoring schedules and duration would be addressed during the remedial design phase. Monitoring costs were developed using costs for similar activities at ANL-W. Activities were estimated to include:

- Semi-annual radiation surveys with a NaI detector around the perimeter and across the surface of the cap
- Annual ANL-W review of monitoring results
- 5-year regulatory review.

Actual monitoring requirements would be specified in the ROD. This alternative is readily implementable. The engineered cover is constructed of natural materials and uses conventional construction

equipment and methods. This barrier design has been selected, designed, and implemented for the INEEL Stationary Low-Power Reactor-1 (SL-1) closure cover. Therefore, the technology, services, and specialists required to implement this barrier are available within the DOE. Construction materials and equipment are expected to be available at the INEEL or in nearby communities. Administrative implementability is considered high, because of the prior application of this design at the INEEL for a similar site.

10.2.3.7 Cost. The cost estimate developed for this alternative is based on constructing the engineered cover, installing surface water diversion controls, using monitoring equipment, conducting geotechnical analyses, and postclosure maintenance and monitoring. The estimated present worth values for constructing and maintaining the engineered cover alternative at OU 9-04 sites are shown in Table 9-1.

Postclosure costs were estimated for the full duration of the 100-year period of maintenance and monitoring. The alternative cost estimates are for comparison purposes only and are not intended for budgetary, planning, or funding purposes.

10.2.3.8 State Acceptance. ANL-W believes that the IDHW/DEQ will not have major comments on the use of this alternative at ANL-W.

10.2.4 Alternative 3b: Native Soil Cover

This alternative was screened (Section 9.6) from this detailed analysis because it does not meet the RAOs for the sites with radiologicaly contaminated soils or for the sites with inorganics that contribute to the ecological risks.

10.2.5 Alternatives 4a and 4b: Conventional Excavation/Disposal

These two alternatives differ only in final disposal location of the contaminated media. Alternative 4a uses an on-site INEEL Soil Respository, while Alternative 4b uses a private disposal facility located off the INEEL. ANL-W will use the private disposal facility of Envirocare in Clive, Utah as the representative off-site facility for cost-estimating purposes. The nine screening criteria are considered to be the same for both alternatives with the exception of the additional transportation costs and potentially larger disposal costs. These two alternatives are retained for detailed analysis for both types of soil categories at OU 9-04 (radiologically contaminated soils and sites with ecological concerns).

10.2.5.1 Overall Protection of Human Health and the Environment. These alternatives provide highly effective, long-term protection of human health and the environment. The removal of all contaminated soil from OU 9-04 sites of concern would eliminate potential long-term human health and environmental concerns associated with future exposure or contaminant migration from uncontrolled waste sites. Both disposal facilities provide consolidation of the contaminated soils within a controlled disposal area where waste management controls are in place and will be maintained for the period of institutional control.

This alternative has the same level of short term protection to the workers during excavation as Alternatives 3a and 3b.

10.2.5.2 Compliance with ARARs and TBCs. Table 10-3 presents the evaluation of these alternatives for compliance with the ARARs and TBCs identified in Tables 7-4 and 7-5, respectively. Compliance with the emissions control ARARs would be ensured by performing excavation using water sprays and other techniques for dust suppression, as needed. 40 CFR 122.26 would be met by engineering controls on runoff.

Location-specific seismic standards would not apply, because no treatment, storage or disposal of hazardous wastes would occur onsite.

State of Idaho rules for Prevention of Significant Deterioration of Air Quality (IDAPA 16.01.01.581) specifically excludes PM-10 increases due to construction, which would be the only expected potential increase of listed pollutants. Dust control during excavation and construction would also help to control emissions.

The excavation and disposal alternative would meet DOE orders that are TBCs by implementing and enforcing applicable provisions of the orders, as described previously in Section 10.2.3.2 for containment alternatives. Therefore, this alternative is capable of complying with all potential ARARs and TBCs identified.

10.2.5.3 Long-Term Effectiveness and Permanence. This alternative has the highest potential for achieving long-term effectiveness and permanence because contaminated soil is completely removed from the site. The long-term risk to human health and the environment is basically transferred from the OU 9-04 sites to a disposal facility.

10.2.5.4 Reduction of Toxicity, Mobility, or Volume Through Treatment. No treatment is associated with this alternative.

10.2.5.5 Short-Term Effectiveness. The exposure risk to workers during excavation and removal of contaminated soil at OU 9-04 sites could be significant. However, radiation monitoring and control measures have been demonstrated to effectively mitigate risks in previous INEEL removal actions. Short-term effectiveness is therefore assessed as moderate. Equipment operator exposures would be minimized to the extent possible. Supplied air and shielding in the form of leaded windows and lead lining on exterior facing surfaces of the equipment would be used as needed. Excavation equipment modified with positive-pressure ventilation system cabs and high-efficiency particulate air filters (HEPA) for use in radioactively-contaminated areas is available at the INEEL from previous remedial actions undertaken at the TRA WWP and elsewhere. If not available onsite, excavation equipment may be supplied by a subcontractor or may be rented or purchased from vendors. The activities associated with removing these soils will require exposure to radioactive materials. The equipment operator risk will be directly related to the time required to perform the excavation along with distance from the soil.

Some slight increase in potential risks to the public could result if contaminated soils were transported off the INEEL for disposal. These risks were not quantified, since previous bulk transportation campaigns of similar soil resulted in no increased risks to the public

Nonexposure risks to workers are also a consideration during excavation. These risks result primarily from physical construction hazards, such as vehicle accidents or personnel injuries. However,

Table 10-3. Evaluation of ARARs and TBC compliance for Alternative 4a and 4b: excavation and disposal.

ARAR Statute	ARAR Type	Citation	Retain ARAR	Met Evaluation
Idaho Fugitive Dust Emissions	Action	IDAPA 16.01.01650 et seq.	Yes	Yes
Toxic Substances	Action	IDAPA 16.01.01161	Yes	Yes
Idaho Hazardous Waste Management Act	Action	- IDAPA 16.01.05.004 and .005 (40 CFR 260. .0 and 261.2—"Definition of Solid Waste" - IDAPA 16.01.05.006 (40 CFR 262.11)—"Hazardous Waste Determination" - IDAPA 16.01.05.005 (40 CFR 261)—"Identification and Listing of Hazardous Waste" - IDAPA 16.01.05.008 (40 CFR 264)—"Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities - IDAPA 16.01.05.011 (40 CFR 268)—"Land Disposal Restrictions"	Yes	Yes
NESHAPS-Radionuclides other than Radon-222 and Radon-220 at DOE facilities -Emission Standard	Chemical	40 CFR 61.92	Yes	Yes
Rules for the Control of Air Pollution in Idaho	Chemical	IDAPA 16.01.01.210, 16.01.01585 and 16.0 .01586	Yes	Yes
Safe Drinking Water Act	Chemical	40 CFR 141	Yes	Yes
National Historic Preservation Act	Location	16 USC 470 et seq.	No	N/A
Storm Water Discharges	Location	40 CFR 122.26	Yes	Yes
Seismic Considerations	Location	IDAPA 16.01.05.008 (40 CFR 264.18 and 270)	No	N/A
Idaho Hazardous Waste Management Act	Location	IDAPA 16.01.05.008	No	N/A
Prevention of Significant Deterioration of Air Quality	Location	IDAPA 16.01.01.581	Yes	Yes
Environmental Protection, Safety, and Health Protection Standards	TBCs	DOE Order 5480.4	Yes	Yes
Radioactive Waste Management	TBCs	DOE Order 5820.2A	Yes	Yes
Radiation Protection of the Public and Environment	TBCs	DOE Order 5400.5	Yes	Yes

ARAR = Rule is an ARAR (Yes/No)
Met Evaluation = The ARAR or TBC is met by alternative
TBC = Rule is a TBC
N/A = Not Applicable.

implementation of appropriate health and safety measures for the excavation activities can minimize these risks.

Environmental impacts resulting from this alternative are dependent on the remedial design and required access areas. The surrounding landscape would likely be disturbed because of the equipment and vehicles moving in and around the site. However, the impact of these activities would be temporary, and the entire site would be restored to match the surrounding landscape at the completion of the project. No environmentally sensitive, archaeological or historical sites, wetlands, or critical habitat exist at the OU 9-04 sites.

RAOs would be achieved by this alternative once excavation and disposal at the INEEL Soil Repository or Envirocare is complete. To satisfy RAOs during implementation of these alternatives, exposures to equipment operators must be reduced below 15 mrem/yr in excess of natural background. Estimates to complete the removal of soils from ANL-W using this alternative would take 6-9 months to complete. However, the estimated time to prepare environmental assessments, safety analyses, and design phases, as well as testing and demonstrating the removal and containment control concepts is 18–24 months.

10.2.5.6 Implementability. Implementation of these alternatives would be moderately difficult because of the complexity of the retrieval system with respect to safety considerations and containment requirements. Significant effort would be required to perform environmental assessments, safety analyses, permit preparations, and equipment modifications (for operator safety), as well as system testing and demonstration. Although the equipment and technology are available to perform the activities specified in these alternatives, increased risks to workers during excavation result in lower implementability, relative to other alternatives.

10.2.5.7 Cost. The estimated cost for the conventional excavation and disposal alternative is high. The implementation requirements identified above significantly increase the cost associated with these alternatives. Two cost estimates were developed for these alternatives and is based on the use and operation of excavation equipment and disposal. Cost allowances are used to account for shielding requirements, air pollution controls, monitoring equipment and analyses, and waste characterization, packaging, and for Alternative 4b transport to Envirocare. The estimated net present values of these alternatives (4a and 4b) are shown in Table 9-1.

The cost analysis for these alternatives assumes that no postclosure monitoring or care is required. The alternative cost estimates are for comparison purposes only and not intended for budgetary, planning, or funding purposes.

10.2.5.8 State Acceptance. ANL-W does not anticipate any major comments from IDHW/DEQ over the use of either of these alternatives.

10.2.6 Alternative 5: Phytoremediation

This alternative is aplicable to both soil categories at WAG 9 (site with radiological contamination and sites with inorganics that pose excessive ecological risks). This alternative involves an in-situ treatment technology to reduce the mobility, toxicity, and volume of the contaminated media. The phytoremediation uses engineered plants grown in the contaminated areas and harvesting these plants and sending the baled

material to an off-site incinerator for disposal. This is a relatively new noninvasive treatment technology that reduces the overall cost of the project while treating the soil and leaving it in a nonhazardous condition. Bench-scale testing has to be performed to determine the most efficient plant species for the contaminants. If this alternative is chosen the bench-scale testing would be performed during the winter of 1997-98 and the first field season would be conducted during the summer of 1998. In addition, if this alternative is selected, a contingent alternative would also be selected in the proposed plan in case the phytoremediation is not reducing the contaminant concentrations.

10.2.6.1 Overall Protection of Human Health and the Environment. This alternative provides highly effective, long-term protection of human health and the environment because the soil would be treated to reduce the mobility, toxicity, and volume of the contaminated soil.

This alternative is also environmentally protective during its' implementation, based on the fact that most of the sites are located inside the fenced area of ANL-W. The plants themselves also act as a natural fence to keep inadvertant human activity out of the sites. The engineered plants are harvested prior to the production of the seeds. This eliminates the posiblity of having animals consume the grains from the plants.

10.2.6.2 Compliance with ARARs and TBCs. Table 10-4 presents the evaluation of this alternative for compliance with the ARARs and TBCs identified in Tables 7-4 and 7-5, respectively. Compliance with the emissions control ARARs is ensured that farming operations (planting and harvesting) would use water sprays and other techniques for dust suppression, as needed. 40 CFR 122.26 would be met by engineering controls on irrigation. 40 CFR 141 would be met through continued groundwater monitoring.

Location-specific seismic standards would be met, because treatment would not be performed within 200 m of a fault active in Holocene times.

State of Idaho rules for Prevention of Significant Deterioration of Air Quality (IDAPA 16.01.01.581) specifically excludes PM-10 increases due to farming, which would be the only expected potential increase of listed pollutants. Dust control measures during farming would also help to control emissions.

DOE Orders 5820.2A and 5400.5 would not apply. DOE 5480.4 would be met by enforcing all applicable provisions of the order. Therefore, this alternative is capable of complying with all potential ARARs and TBCs identified.

10.2.6.3 Long-Term Effectiveness and Permanence. This alternative has the highest potential for achieving long-term effectiveness and permanence because contaminated soil would be remediated to levels that are protective of human health and the environment.

10.2.6.4 Reduction of Toxicity, Mobility, or Volume Through Treatment. The in-situ treatment of the contaminated media with the phytoremediation would reduce the toxicity, mobility, and volume of the contaminated soil. After being treated using phytoremediation the soil will be tested to ensure that the PRGs have been met. Phytoremediation has been used successfully to remove radionuclide and inorganics from mine sites and ANL-W anticipates that it would also be effective at removing contamination at the ANL-W faciltiy.

Table 10-4. Evaluation of ARARs and TBC compliance for Alternative 5: phytoremediation.

ARAR Statute	ARAR Type	Citation	Retain ARAR	Met Evaluation
Idaho Fugitive Dust Emissions	Action	IDAPA 16.01.01650 et seq.	Yes	Yes
Toxic Substances	Action	IDAPA 16.01.01161	Yes	Yes
Idaho Hazardous Waste Management Act	Action	- IDAPA 16.01.05.004 and .005 (40 CFR 260.10 and 261.2—"Definition of Solid Waste" - IDAPA 16.01.05.006 (40 CFR 262.11)—"Hazardous Waste Determination" - IDAPA 16.01.05.005 (40 CFR 261)—"Identification and Listing of Hazardous Waste" - IDAPA 16.01.05.008 (40 CFR 264)—"Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities - IDAPA 16.01.05.011 (40 CFR 268)—"Land Disposal Restrictions"	Yes	Yes
NESHAPS-Radionuclides other than Radon-222 and Radon-220 at DOE facilities -Emission Standard	Chemical	40 CFR 61.92	No	N/A
Rules for the Control of Air Pollution in Idaho	Chemical	IDAPA 16.01.01.210, 16.01.01585 and 16.01.01586	Yes	Yes
Safe Drinking Water Act	Chemical	40 CFR 141	Yes	Yes
National Historic Preservation Act	Location	16 USC 470 et seq.	No	N/A
Storm Water Discharges	Location	40 CFR 122.26	Yes	Yes
Seismic Considerations	Location	IDAPA 16.01.05.008 (40 CFR 264.18 and 270)	No	N/A
Idaho Hazardous Waste Management Act	Location	IDAPA 16.01.05.008	Yes	Yes
Prevention of Significant Deterioration of Air Quality	Location	IDAPA 16.01.01.581	Yes	Yes
Environmental Protection, Safety, and Health Protection Standards	TBCs	DOE Order 5480.4	Yes	Yes
Radioactive Waste Management	TBCs	DOE Order 5820.2A	No	No
Radiation Protection of the Public and Environment	TBCs	DOE Order 5400.5	No	No

ARAR = Rule is an ARAR (Yes/No)
Met Evaluation = The ARAR or TBC is met by alternative
TBC = Rule is a TBC
N/A = Not Applicable.

10.2.6.5 Short-Term Effectiveness. Any health risks to workers during phytoremediation could be effectively mitigated using standard administrative and engineering controls including dust suppression and appropriate PPE. Typically the contaminants are bonded into the plant biomass, thus limiting the pathway to the human receptors. Short-term effectiveness is therefore assessed as high. Equipment operator exposures would be minimized to the extent possible. Farming equipment could be modified with positive-pressure ventilation system cabs and HEPA filters for use in radioactively-contaminated areas if necessary.

Environmental impacts for this alternative are minimal. Most of the contaminated sites are within the ANL-W fenced area and the contaminants are bonded inside the biomass of the plant. The baled biomass plant matter will be sent to an on-site incinerator for disposal, the radionuclides, and inorganics will be filtered in the emissions stack. No environmentally sensitive, archaeological or historical sites, wetlands, or critical habitat exist at ANL-01A.

If the phytoremediation alternative works for the ANL-W soils, the RAOs would be attained after the verification samples show the levels of the contaminants are less then the PRGs. Bench-scale tests will determine the estimated number of field seasons that are required to perform remediation. If this alternative is selected, ANL-W will use the estimated number of field seasons from the bench-scale testing along with the verification samples collected after completion of the 1998 field season. If after collection of the 1999 verification sampling of the site shows that the phytoremediation is not working, ANL-W will then use the contingent alternative that was selected in the record of decision. However, for the cost estimate, ANL-W will use five field seasons to reduce the contaminant levels to levels below the PRGs.

10.2.6.6 Implementability. This alternative is completely implementable. Most of the sites are within the ANL-W facility fences and would not require additional fencing to deter fauna or human access. In addition, most of the sites are old ditches that have the contamination in the bottoms of the ditches. These ditches can be flood irrigated to supply additional water necessary for crop growth. Areas outside the ANL-W facility can be irrigated by using common piping and the EBR-II deep well #1. The farming equipment is commercially available and would consist of a mini tractor fitted with a drill, mower, and baler. The INEEL has an incinerator on-site that would be able to accept both radiological and inorganicly contaminated plant matter. Transportation to the incinerator would entail using a puplic highway for approximately 15 miles.

10.2.6.7 Cost. The estimated cost for this alternative is identified in Table 9-1. The cost analysis for this alternative assumes that no postclosure monitoring or care is required. Based on the fact that once the PRGs have been met because the contaminats would have been treated to reduce the toxicity, mobility, and volume. The costs of the in-situ phytoremediation are typically one-tenth of those common to excavation and disposal. The cost estimate assumes that the PRGs would be met after five field seasons. Note that ANL-W plans on planting two or three crops each of the field seasons. The alternative cost estimates are for comparison purposes only and not intended for budgetary, planning, or funding purposes.

10.2.6.8 State Acceptance. ANL-W beleives that the IDHW/DEQ will not have any major comments on the use of this alternative at OU 9-04.

10.3 Comparative Analysis

The comparative analysis provides a measure of the relative performance of alternatives against each evaluation criterion. The purpose of this comparison is to identify the relative advantages and disadvantages associated with each alternative. The comparative analysis does not identify a preferred alternative, but provides sufficient information to enable the selection of a preferred alternative by the appropriate decision makers (DOE-CH, EPA, and IDHW). The following sections present the alternative comparisons relative to each evaluation criterion, for each grouping of sites. Table 10-5 summarizes how each alternative satisfies the RAOs identified in Section 7.1. Table 10-6 provides a narrative description of the relative performance of each alternative for each evaluation criterion while Table 10-7 summarizes the relative ranking of the alternatives. Each of the following sections compares the rankings of each alternative for the radioloigally contaminated soils and sites with ecological concerns. Each of the alternatives are presented in ranking order from highest to lowest.

10.3.1 Overall Protection of Human Health and the Environment

10.3.1.1 Radiologically Contaminated Sites. The primary measure of this criterion is the ability of an alternative to achieve RAOs for the OU 9-04 sites. Alternative 5 would also provide effective long-term protection of human health and the environment because the soils concentrations would be reduced to the PRG levels. Alternatives 4a and 4b (conventional excavation and landfill disposal) are ranked second because they do not remove contamination from the soils and only provide protection of human health and the environment through off-site disposal. Alternative 3a is ranked third because it would prevent the exposure of the Cs-137 for the 130 years but the effectiveness of these on the Ra-226 with the longer half-life is questionable. The results of the BRA indicate that Alternative 1 (no action) would not prevent exposures resulting in risks greater than 1E-04 and this alternative is ranked last in overall protection of human health and the environment.

10.3.1.2 Ecological Sites of Concern. For the OU 9-04 sites with ecological concerns because of inorganics, the Alternatives are ranked in the same order as those of the radioligical sites. This ranking order is Alternative 5 followed by Alternative 4a and 4b, followed by Alternative 3a and finally alternative 1. Alternative 5 is the only treatment process that is retained and would provide long-term protection of the environment by reducing the concentrations of the contaminants to acceptable levels. Alternatives 4a and 4b provide the protection of human helath and the environment because the wastes would be movedto an off-site disposal area. Alternative 3a does provide protection of human health and the environment as long as the integrity of the cover is maintained. The longevity of Alternative 3a is questionable after the institutional control period has ended. Alternatives 1 does not meet the RAOs.

10.3.2 Compliance with ARARs

10.3.2.1 Radiologically Contaminated Sites. Comparison of compliance with ARARs for the alternatives that are evaluated in detail is summarized in Table 10-6. The relative ranking of the alternatives for the radiologically contaminated sites with respect to compliance with ARARs is shown in Table 10-7. However, IDAPA 16.01.01.650, the Fugitive Dust Control ARAR, could apply to OU 9-04 sites, regardless of whether or not remedial construction and/or operations occur, and would not be met by the no action alternative. If toxic metals or organics were present in the fugitive dust, then IDAPA 16.01.01.210,

Table 10-5. Comparison of alternatives with RAOs.

Criteria	Alternative 1 No action	Alternative 3a: Engineered cover	Alternative 4a: Conventional excavation and off-site disposal at INEEL Soil Repository	Alternative 4b: Conventional excavation and off-site disposal at a private facility	Alternative 5: Phytoremediation
RAOs for contaminated soil					
Protection of human health					
Inhibit external exposure	No additional exposure prevention provided beyond any existing soil cover.	Exposure to penetrating radiation prevented by shielding from 4 ft (1.2 m) thick protective cover.	Eliminates potential exposure by removing contamination from OU 9-04..	Eliminates potential exposure by removing contamination from OU 9-04..	Treatment process reduces the concentration of contamination to acceptable levels.
Inhibit ingestion of soil	No ingestion prevention provided beyond any existing soil cover.	Ingestion prevented by isolating contamination beneath a protective cover.	Eliminates potential ingestion by removing contamination from OU 9-04.	Eliminates potential ingestion by removing contamination from OU 9-04.	Treatment process reduces the concentration of contamination to acceptable levels.
Inhibit degradation of low-level soil repository covers	No protection provided beyond any existing soil cover.	Protection provided for 100 year institutional control period.	NA	NA	NA
Protection of environment					
Inhibit adverse effects to resident populations	No control of environmental exposure to contaminated surface soil beyond any existing soil cover provided.	Provides isolation of contamination from the accessible environment for at least 130 years.	Eliminates the contamination from OU 9-04.	Eliminates the contamination from OU 9-04.	Treatment process reduces the concentration of contamination to acceptable levels.
Inhibit adverse effects to buried COCs.	No control of adverse effects to OU 9-04 sites beyond any existing soil cover.	Protective cover is resistant to erosion and intrusion that could result in exposing contamination to the accessible environment.	Removal of contamination from the site eliminates potential adverse effects.	Removal of contamination from the site eliminates potential adverse effects.	Treatment process reduces the concentration of contamination to acceptable levels.

16.01.01.585 and 16.01.01.586 are ARARs that would not be met because no controls would be implemented. Storm water discharge rules would simi arly not be met. DOE orders limiting exposures to workers and hypothetical future residents would not be met in the absence of controls.

Alternative 5 is ranked the highest because of the non-evasive treatment of the contaminated soils would result in no emissions of fugive dust. Alternatives 3a, 4a, and 4b are ranked equally, since all are considered equally capable of achieving compliance through use of engineering controls to meet the State of Idaho regulations for controlling emissions of fugitive dust and toxic substances and other ARARs. Alternative 1 does not meet the RAOs and is ranks the lowest for compliance with ARARs.

10.3.2.2 Ecological Sites of Concern. The relative ranking of the alternatives with respect to compliance with ARARs is shown in Table 10-7. Relative rankings of compliance with ARARs shows that Alternatives 3a, 4a, 4b and 5 are all considered equal in this ranking. Alternative 1 does not meet the RAOs and is ranked the lowest.

10.3.3 Long-Term Effectiveness and Permanence

10.3.3.1 Radiologically Contaminated Sites. Alternative 5 would provide the highest degree of long-term effectiveness and permanence, because the contamination would have been reduced to the PRGs. Alternative 4a and 4b provide the next highest degree of long-term effectiveness and permanence, because contaminated soil would no longer exist at the sites. Alternative 3a would be effective as long as the cap is resistant to erosion, and to human and biotic intrusion. Alternative 1 does not meet the RAOs and is ranked the lowest.

10.3.3.2 Sites with Ecological Concerns. Long-term effectiveness and permanence is best for Alternative 5 because the soil concentrations would meet the PRGs. Alternatives 4a and 4b are ranked next because the contamination would no longer exist at the ANL-W site. Alternative 3a is ranked next because its long-term effectiveness and permanence depends on the maintanence and upkeep of the cap. Alternative 1 was ranked last because it does not provide any long-term effectiveness or permancence for the ecological receptors.

10.3.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

This criterion applies only to Alternative 5 because it is the only treatment alternative that was retained for detailed analysis. Oviously, this alternative would be ranked the highest for the sites with radiological contamination and sites with inorganics that pose ecological concerns.

10.3.5 Short-Term Effectiveness

10.3.5.1 Radiologically Contaminated Soil Sites. The relative ranking of the alternatives with respect to short-term effectiveness is shown in Table 10-7. These sites are not located near inhabited areas and no public roads are in the vicinity. No significant impacts to worker and surrounding communities would

Table 10-6. Detailed analysis summary for OU 9-04 sites.

Criteria	Alternative 1 No action	Alternative 3a Engineered cover	Alternative 4a: Conventional excavation and off-site disposal at INEEL Soil Repository	Alternative 4b: Conventional excavation and off-site disposal at private facility	Alternative 5: Phytoremediation
Overall protection of human health and the environment					
Human health protection	No reduction in risk.	Cap would prevent direct exposure to contaminated soil and debris for over 130 years. Minimal exposure risks during cap construction.	Eliminates potential exposure from contaminated soil at site. Protectiveness is based on completely removing contamination from site. Short-term risk is moderate due to direct exposure during excavation.	Eliminates potential exposure from contaminated soil at site. Protectiveness is based on completely removing contamination from site. Short-term risk is moderate due to direct exposure during excavation.	Treatment reduces the potential exposure from contaminated soil at site to acceptable levels. Long term protectiveness is based on reduction of the concentrations. Short-term risk is low.
Environmental protection	Allows possible migration of contaminated surface soil by wind and surface water erosion.	Provides effective protection for over 130 years. Minimal environmental impacts during construction.	Eliminates contamination from site.	Eliminates contamination from site.	The treatment reduces the contaminant concentrations below the PRGs.
Compliance with ARARs					
Action-specific					
Idaho Fugitive Dust Emissions-IDAPA 16.01.01650 et seq.	Would not meet ARAR because no controls would be implemented	Will meet ARAR by eliminating potential for windblown soil contamination	Will meet ARAR by eliminating potential for windblown soil contamination	Will meet ARAR by eliminating potential for windblown soil contamination	Will meet ARAR by eliminating potential for windblown soil contamination after treatment.
Idaho Hazardous Waste Management Act-IDAPA 16.01.05.004 et seq.	NA	Would meet permeability requirements for "landfill closure" for ANL-01A-MCTBD soils.	Would meet ARAR for "clean closure" for ANL-01A-MCTBD soils.	Would meet ARAR for "clean closure" for ANL-01A-MCTBD.	Would meet ARAR.

Table 10-6. (continued).

Criteria	Alternative 1 No action	Alternative 3a Engineered cover	Alternative 4a: Conventional excavation and off-site disposal at INEEL Soil Repository	Alternative 4b: Conventional excavation and off-site disposal at private facility	Alternative 5: Phytoremediation
Toxic Substances-IDAPA 16.01.01161	NA	Will meet ARAR by eliminating potential for windblown soil contamination	Will meet ARAR by eliminating potential for windblown soil contamination	Will meet ARAR by eliminating potential for windblown soil contamination	Will meet ARAR by eliminating contaminant concentrations and potential for windblown material because of the plant cover.
Chemical-specific					
NESHAPS-40 CFR 61.92	NA	Would meet ARAR by controlling the source term for all exposure pathways.	Would meet ARAR by eliminating the source term for all exposure pathways.	Would meet ARAR by eliminating the source term for all exposure pathways.	Would meet ARAR by treating the soils so the contaminants are below the PRGs for all exposure pathways.
Rules for the Control of Air Pollution in Idaho-IDAPA 16.01.01.210, 16.01.01585 and 16.01.01586	Would not meet ARAR if toxic metals or organics were present in fugitive dust, because no controls would be implemented.	Would meet ARAR through use of engineering controls.	Would meet ARAR by removing contamination from site.	Would meet ARAR by removing contamination from site.	Would meet ARAR by treatment to reduce the contamination to levels below the PRGs.
Safe Drinking Water Act-40 CFR 141	Would be met through continued groundwater monitoring.	Would be met through continued groundwater monitoring.	Would be met through continued groundwater monitoring.	Would be met through continued groundwater monitoring.	Would be met through continued groundwater monitoring.
Location-specific					
National Historic Preservation Act-16 USC 470 et seq.	NA	NA	NA	NA	NA
Storm Water Discharges- 40 CFR 122.26	Would not meet ARAR because no controls would be implemented.	Would meet ARAR through use of engineering controls.	Would meet ARAR by removing contamination from site.	Would meet ARAR by removing contamination from site.	Would meet ARAR through treament to reduce the contaminants to meet the PRGs.
Seismic considerations-IDAPA 16.01.05.008 (40 CFR 264.18 and 270)	NA	Would meet ARAR-no site within 200 m of a Holocene fault.	NA	NA	Would meet ARAR- site is not within 200 m of a Holocene fault.

Table 10-6. (continued).

Criteria	Alternative 1 No action	Alternative 3a Engineered cover	Alternative 4a: Conventional excavation and off-site disposal at INEEL Soil Repository	Alternative 4b: Conventional excavation and off-site disposal at private facility	Alternative 5: Phytoremediation
Idaho Hazardous Waste Management Act-Location Standards	NA	Would meet ARAR-no site within 200 m of a Holocene fault.	NA	NA	Would meet ARAR- site is not within 200 m of a Holocene fault.
Prevention of Significant Deterioration of Air Quality	NA	Would meet ARAR-construction activities excluded from PM-10 provisions.	Would meet ARAR-construction activities excluded from PM-10 provisions.	Would meet ARAR-construction activities excluded from PM-10 provisions.	NA, Farming activities would not deteriorate air quality. Volume reduction of the biomass would be completed at the INEEL site incinorator that has the appropriate filters and permits.
TBCs					
Environmental Protection, Safety, and Health Protection Standards-DOE Order 5480.4	Would not meet TBC because no controls would be implemented.	Would meet TBC through use of engineering and institutional controls and best management practices.	Would meet TBC through use of engineering and institutional controls and best management practices..	Would meet TBC through use of engineering and institutional controls and best management practices..	Would meet TBC through use of engineering and institutional controls and best management practices.
Radioactive Waste Management-DOE Order 5820.2A	Would not meet TBC because no controls would be implemented.	Would meet TBC through use of engineering and institutional controls and best management practices.	Would meet TBC through use of engineering and institutional controls and best management practices.	Would meet TBC through use of engineering and institutional controls and best management practices.	Would meet TBC through use of engineering and institutional controls and best management practices. Final incinoration of biomas would be conducted in an approved facility.
Radiation Protection of the Public and Environment-DOE Order 5400.5	Would not meet TBC because no controls would be implemented.	Would meet TBC through use of engineering and institutional controls and best management practices.	Would meet TBC through use of engineering and institutional controls and best management practices.	Would meet TBC through use of engineering and institutional controls and best management practices.	Would meet TBC through use of engineering and institutional controls and best management practices.Final incinoration of biomas would be conducted in an approved facility.

Table 10-6. (continued).

Criteria	Alternative 1 No action	Alternative 3a Engineered cover	Alternative 4a: Conventional excavation and off-site disposal at INEEL Soil Repository	Alternative 4b: Conventional excavation and off-site disposal at private facility	Alternative 5: Phytoremediation
Long-term effectiveness and permanence					
Magnitude of residual risk	No change from existing risk.	Source-to-receptor pathways eliminated while cap remains in place. Inherent hazards of inorganics would remain. Cs-137 within 1E-04 acceptable range after 130 years. Ra-226 within 1,600 years.	No reduction in contaminant concentrations. All contaminated soils would be removed from site and transported for disposal at another facility.	No reduction in contaminant concentrations. All contaminated soils would be removed from site and transported for disposal at another facility.	In-situ treatment of the soils would result in contaminant levels that are below the PRGs.
Adequacy and reliability of controls	No control and, therefore, no reliability.	Limited access to contaminated soil and environmental monitoring effective only during institutional period of control (at least 100 years). Barrier control over contaminated soil for at least 130 years.	Disposal facility is assumed to provide adequate and reliable control over disposed soil and debris for the period of institutional controls.	Disposal facility is assumed to provide adequate and reliable control over disposed soil and debris for the period of institutional controls.	Phytoremediation treatment has been successfully used in mining applications. Contingency alternative could be selected if phytoremediation is not working at ANL-W.
Reduction of toxicity, mobility, or volume through treatment					
Treatment process used	NA	NA	NA	NA	Phytoremediation.
Amount destroyed or treated	NA	NA	NA	NA	All radioactively and inorganicly contaminated soils above the PRGs.
Reduction of toxicity, mobility, or volume	NA	NA	NA	NA	No reduction in toxicity, the most mobile contaminats will be removed, and no increase in volume of contaminated soil. The volume of biomass would be incinerated to reduce volume to be disposed.
Irreversible treatment	NA	NA	NA	NA	Yes
Type and quantity of residuals remaining after treatment	NA	NA	NA	NA	The soils remaining after treatment will contain contaminants below the PRGs. The soil can be reused for any application such as farming, or community development.

Table 10-6. (continued).

Criteria	Alternative 1 No action	Alternative 3a Engineered cover	Alternative 4a: Conventional excavation and off-site disposal at INEEL Soil Repository	Alternative 4b: Conventional excavation and off-site disposal at private facility	Alternative 5: Phytoremediation
Statutory preference for treatment	NA	NA	NA	NA	Treatment method is relatively new and more plant species are being tested for their affinity to bioaccumulate contaminats.
Short-term effectiveness					
Community protection	No increase in potential risks to the public.	No increase in potential risks to the public.	Slight increase in potential risks to the public during off-site transportation.	Slight increase in potential risks to the public during off-site transportation.	No increase in potential risks to the public.
Worker protection	No increase or decrease in potential risks to the worker.	Worker risk during barrier installation is minor due to shielding afforded by existing clean soil and engineering controls.	Worker risk during barrier installation is minor due to shielding afforded by existing clean soil and engineering controls.	Worker risk during barrier installation is minor due to shielding afforded by existing clean soil and engineering controls.	Worker risk from exposure to contaminated soil during farming activities will require administrative and engineering controls.
Environmental impacts	No change from existing conditions.	Limited to disturbances from vehicle and material transport activities associated with barrier construction. Limited potential for airborne contamination in the form of fugitive dust, due to use of engineering controls.	Limited to disturbances from vehicle and material transport activities associated with excavation. Limited potential for airborne contamination in the form of fugitive dust, due to use of engineering controls.	Limited to disturbances from vehicle and material transport activities associated with excavation. Limited potential for airborne contamination in the form of fugitive dust, due to use of engineering controls.	Limited increase in animal usage of the sites outside the ANL-W facility during the phytoremediation. Limited potential for airborne contamination in the form of fugitive dust, due to use of engineering controls.
Time until action is complete	NA	Approximately 12 to 15 months.	Approximately 18 to 24 months.	Approximately 18 to 24 months.	Estimated to be 5 years based on the use of multiple plantings per field season.
Implementability					
Ability to construct and operate	No construction or operation.	Involves available construction technology.	Somewhat difficult, due to safety requirments for ANL-W and LMITCO.	Somewhat difficult, due to safety requirements rom both ANL-W and LMITCO. Potential scheduling problesms because of rail shipment to off-site private faciltiy.	Small farming equipment is readily available. Site application to select plant species, soil amenities, irrigation schedules, and disposal of biomass will be determined per field season.

Table 10-6. (continued).

Criteria	Alternative 1 No action	Alternative 3a Engineered cover	Alternative 4a: Conventional excavation and off-site disposal at INEEL Soil Repository	Alternative 4b: Conventional excavation and off-site disposal at private facility	Alternative 5: Phytoremediation
Ease of implementing additional action if necessary	May require repeat of feasibility study/ record of decision process.	Additional remedial actions would be difficult, as the barrier is intended to prevent access to contamination. Barrier would require removal.	Additional remedial action would not be necessary, as all contaminated soil and debris are removed from site.	Additional remedial action would not be necessary, as all contaminated soil and debris are removed from site.	Use of this treatment technology would not inhibit the use of a different alternative later.
Ability to monitor effectiveness	Monitoring of conditions is readily implemented.	Barrier performance can be monitored through radiation surveys, and can be visually assessed on the basis of physical integrity.	The effectiveness in removing all contaminated materials associated with site is easily monitored.	The effectiveness in removing all contaminated materials associated with site is easily monitored.	The effectiveness in removing contaminants to levels below the PRGs can be determined through sampling. Once the soil is treated future monitoring would not be refquired.
Ability to obtain approvals and coordinate with regulatory agencies	No approvals required.	No difficulties identified.	Potentially difficult due to additional requirements for environmental assessments, safety analyses, and ARARs compliance.	Potentially difficult due to additional requirements for environmental assessments, safety analyses, and ARARs compliance.	No difficulties identified
Availability of services and capacity	None required.	Barrier design and services reside within the DOE and are considered readily available to the INEEL.	Services available either onsite or offsite through subcontractor.	Services available either onsite or offsite through subcontractor.	Services available either onsite or offsite through subcontractor.
Availability of equipment, specialists, and materials	None required	Equipment and materials are readily available at the INEEL or within surrounding communities.	Equipment and materials are either available onsite, through subcontractors or will be purchased. Trained specialists are available within the communities surrounding the INEEL.	Equipment and materials are either available onsite, through subcontractors or will be purchased. Trained specialists are available within the communities surrounding the INEEL.	Equipment and materials are either available onsite or through subcontractors.
Availability of technology	None required	Readily available at the INEEL.	Readily available at the INEEL.	Readily available at the INEEL.	Readily available inhouse with experienced personnel.
Cost (present worth)	See Table 9-1	See Table 9-1	See Table 9-1	See Table 9-1	See Table 9-1

NA = Not Applicable

Table 10-7. Relative ranking of OU 9-04 site grouping remedial alternatives with respect to CERCLA evaluation criteria. Ranking is from highest to lowest and only for those alternatives that meet the RAOs are shown.

Evaluation criteria	Radiologically contaminated soils	Sites with Ecological concerns
Overall protection of human health and the environment	5, 3a = 4a = 4b, 1	5, 3a = 4a = 4b, 1
Compliance with ARARs	5, 3a = 4a = 4b, 1	5, 3a = 4a = 4b, 1
Long-term effectiveness and permanence	5, 4a = 4b, 3a, 1	5, 4a = 4b, 3a, 1
Reduction of toxicity, mobility or volume through treatment[1]	5	5
Short-term effectiveness	1, 3a = 5, 4a, 4b	1, 3a = 5, 4a, 4b
Implementability	1, 5, 3a = 4a = 4b	1, 5, 3a = 4a = 4b
Cost	1, 5, 4a, 4b, 3a	1, 5, 4a, 4b, 3a

1 = No Action Alternative

2 = Limited Action Alternative

3a = Containment w/engineered cover Alternative

3b = Containment w/native soil cover Alternative

4a =Excavation/disposal on-site INEEL Soil Repository Alternative

4b =Excavation/disposal off-site private facility Alternative

5 =Phytoremediaton Alternative

NA = Not applicable.

= No significant difference between alternatives with respect to the criterion.

be anticipated. Potential contaminant migration from surface soil exists in the form of wind and water erosion. Alternative 1 is ranked the highest because no activities would be conducted in these sites that could potentially effect workers or surrounding communities. Alternatives 3a and 5 are ranked the same and higher than Alternative 4a because the wastes would remain on site away from the public and the use of a public highway. Alternative 4a is ranked slightly ahead of Alternative 4b because of its lack of rail transport to a private disposal facility.

For all alternatives, engineering controls would be used to minimize the exposure risks to workers. Personal protective equipment and adherence to health and safety protocols would minimize exposures while in the sites. For the Alternative 3a, existing clean soil and initial foundation layers would likely provide sufficient shielding to reduce direct exposure of workers to acceptable levels. Environmental impacts are considered minimal and result primarily from cap construction activities. Fill material placed as a cap foundation would prevent contaminant migration to the surrounding environment in addition to providing shielding for workers.

10.3.5.2 Sites with Ecological Concerns. The relative ranking of the alternatives for the sites with ecological concerns with respect to short-term effectiveness is shown in Table 10-7. These rankings are the same as those for the radioligically contaminated soils. The ranking order of the alternatives is 1, 3a = 5, 4a, and 4b. The reasons for the short-term effectiveness isalso the same as those of the radioligically contaminated soil sites.

10.3.6 Implementability

10.3.6.1 Radiologically Contaminated Sites. Each of the alternatives retained for detailed analysis is technically implementable. The relative ranking of the alternatives with respect to implementability is shown in Table 10-7. Alternative 1 is ranked the highest but it does not meet the RAOs. Alternative 5 is ranked the next highest because the technology uses commercially available farming equipment to plant and harvest the plants. Alternatives 3a, 4a, and 4b are ranked the same because they will require the use of similar construction equipment and applicable permits to complete. These permits would consist of safe work permits, digging permits, radiation safe work permits, transportation placards, and applicable RCRA disposal permits.

10.3.6.2 Sites with Ecological Concerns. The relative ranking of the alternatives for the sites with ecological concerns with respect to implementability is shown in Table 10-7. These rankings for the ecological sites are the same as those for the sites with radiological contaminats. Oviously this is a result of all alternatives that were retained for detailed analysis were applicable for both radiological and ecological sites. See the discussion in Section 10.3.6.1 for detailed comparative analysis of the alternatives.

10.3.7 Cost

The relative ranking of the alternatives for all site groupings with respect to present worth cost is presented in ascending order in Table 10-7. The level of detail used to develop the cost estimates presented in Table 9-1 is considered appropriate for comparing alternatives. Separate cost line items are developed for the primary components of each remedial action alternative, such as monitoring; capping; excavation; disposal; and reporting requirements such as remedial design/remedial action scope of work, remedial design/remedial action work plans, safety documentation, and progress reports.

The level of detail presented in the cost estimates is consistent with the level of detail provided in the descriptions of each alternative. Additional details in the cost estimates are not considered appropriate without supporting detailed designs for each alternative. The uncertainty associated with each cost estimate increases with the complexity of the alternative. Consequently, the cost estimates developed for Alternatives 4 and 5 have the highest uncertainty.

10.3.8 State Acceptance

To date, the only comments ANL-W has received have been on the document titled the OU 9-04 Comprehensive Remedial Investigation/Feasibility Study (draft) that was dated June 1997. These comments have been incorporated or otherwise resolved prior to incorporation into this draft final OU 9-04 RI/FS report.

10.4 References

Anderson, J. E., et al., 1987, "Control of Soil Water Balance by Sagebrush and Three Perennial Grasses in a Cold-desert Environment," *Arid Soil Research and Rehabilitation* 1, pp. 229–244.

EPA, 1988, *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA*, EPA/540/G-89/004, Interim Final, U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, October.

Valentich, D. J., 1993, Full-Scale *Retrieval of Simulated Buried Transuranic Waste*, EGG-WTD-10895, EG&G Idaho, Inc., September.